IV. "Description of the great Melbourne Telescope." By T. R. Robinson, D.D., F.R.S., and Thomas Grubb, Esq., F.R.S. Received June 11, 1868.

(Abstract.)

The authorities of the colony of Victoria formed (in 1862) the wish to establish, in connexion with their new observatory at Melbourne, a powerful telescope for observing the Southern Nebulæ, and applied, through the Duke of Newcastle, to the President and Council of the Royal Society for encouragement and advice. That body had in former years given much attention to this subject, and had received a report from a Committee on it, in the hope of inducing the British Government to take such a step. The same Committee was consulted, and made another report almost identical with the first. In consequence of it, the Legislature of Victoria ordered the construction of the telescope in 1865, which was undertaken early in the following year by Mr. Grubb, under the direction of a Committee consisting of the late Earl of Rosse, Dr. Robinson, and Mr. W. De La Rue. After Lord Rosse's death, his son, the present Earl, was appointed in his stead by the President. It has been very successfully completed; and it is thought that some account of it, and the notable things that occurred in its progress, may deserve a record. As an introduction to this account, a notice of the reasons which guided the Committee in some of their decisions may be useful.

1. They chose a four-feet Reflector, because, from the experience gained with Lord Rosse's and Mr. Lassell's telescope, they were satisfied that this aperture was sufficient for the work proposed, and also because it had not been proved that a larger one could be equatorially mounted with the requisite firmness and ease of motion. This last, however, has been convincingly disposed of by the present experiment.

2. They chose the Reflector in preference to the Achromatic, because it is not probable that one of the latter will ever be made which shall equal a four-feet in light, and because, if it were, the cost of it would be tremendous. One of the Committee got from a great continental optician an estimate for one of 30 inches, which would have amounted, complete, to £20,000, and been far inferior in power. Absurd exaggeration is not uncommon in comparing these two kinds of telescopes, but is easily refuted. A speculum reflects, after years of use, 0·64 of the incident light, which is the intensity of Herschel's front view. In the Newtonian the coefficient is 0·401; in the Achromatic light is lost from two causes:—first, by reflection at each of the four surfaces of its lenses. This can be calculated from Fresnel's formula, and gives the coefficient of intensity 0·81, whence the equivalent to a four-feet Newtonian is not less than 33 inches. Secondly, it must be greater than this; for no glass is perfectly transparent, and therefore absorbs light according to a law depending on its thickness and a certain constant. Dr. Robinson discusses this, and comes to the con-

clusion that the equivalent Achromatic will certainly not be less than 3 feet, and may be much more. He adduces experimental facts in support of this, and points out the conditions which are necessary for a fair comparison of the two kinds.

3. The tube was to be metal lattice-work. This plan, originally proposed by Sir J. Herschel, had been tried by Lord Rosse, Mr. Lassell, and Mr. W. De la Rue, with marked advantage; its main purpose is to diminish the evils caused by currents of unequally heated air eddying in the tube.

4. They decided that the speculum should be metal, and not silvered glass. It seemed imprudent to risk the success of the undertaking by venturing on an experiment whose success was not assured; it was not known whether the silver could be uniformly deposited on so large a scale; some facts appear to show that glass is more liable to irregular action than speculum metal; and the intensity of the light in these telescopes is not as great as had been expected.

5. The telescope was to be a Cassegrain, not a Newtonian; and this was the result of long discussion. This form is little known, for Newton's hostility to it has created a prejudice against it. Its chief defect is the difficulty of getting a magnifying power so low that the eye can only take in the whole pencil, as the first image is magnified from five to six times by the second speculum. This requires a huge eyepiece, of which the lenses are costly, and, by their thickness, intercept light. One defect attributed to it by Newton proves to be an advantage; he thought that the reflection of metal is like that of glass, faintest at perpendicular incidence, but increasing in intensity with the obliquity; therefore brighter in his telescope at 45° than in the other nearly perpendicular. But it is now known that the law is different, so that the reflection at 45° is $\frac{1}{20}$ less powerful than the other. The chief advantage of the Cassegrain, and that which influenced the Committee, is its extreme convenience to the observer; he is near the ground, and has to move through a small space to command the whole sky, instead of standing on a structure nearly 40 feet high, which cannot be used without fatigue and even danger.

Then formulæ are given for finding the constants of the telescope; the foci of its specula are 366 and 75 inches, its lowest power 240, and its extreme field of view 14′·3.

The composition of the specula is Lord Rosse's, four equivalents of copper and one of tin, respecting which much detail is given; and still more of the process of casting the first speculum, which took place July 3, 1866. This was managed according to the method of Lord Rosse, with some modification, caused by the necessity of having a projecting band round the edge of the speculum, and an aperture in its centre. It was conducted without accident, and safely transferred to the annealing-oven, in which a thermocouple of platinum and iron was inserted, which, at the end of twenty-four days, showed that it was completely cooled. It came

out perfectly sound, but was a little "in winding," and had Lord Rosse's "Crowsfeet" on part of its surface. These might have been ground out, but Mr. Grubb preferred recasting it. It was broken by an iron ram of 70 lbs. falling four feet. When the blows were applied through a bar of wood, they did nothing; but the first one through iron broke it into four equal pieces. These, when put together, fitted exactly, showing that there was no unequal shrinkage in cooling. Some changes were made before the second casting, on Sept. 22. The hoop-bed of the mould was much strengthened; the core, which formed the central aperture, and seemed to interfere with the regular flow of the metal, was raised $1\frac{1}{2}$ inch above the mould; and this last set on a strong cast-iron frame, which could be inclined at pleasure. It was sloped, so that at the first part of the pouring the melted alloy filled it from its lower edge to its middle; it was then lowered rapidly to be horizontal while the pouring was completed. When it came from the oven, the central disk, which was under the core, was cut out. This, as well as the third casting, which was made November 24, came out perfect.

A description is given of the polishing machine, which is remarkable for its smooth and equable action, and not less so for the facility it gives of testing the figure of the speculum during the polishing. Removing the polisher (which is built up of wood, so as to combine great strength and lightness), one man, by turning a winch, sets the speculum upright. Doors are opened, and by an eyepiece properly placed a dial or artificial star at a suitable distance is examined. The specula were ground flat at their back, and true at their edges; and their focal lengths differ only $1\frac{1}{2}$ inch.

Not less important than the perfect figure of a speculum is its being so supported both at the back and edge that it may be subjected to no irregular pressure, for to such it is almost inconceivably sensitive. The arrangements to secure this are very elegant, and have proved entirely successful.

The lattice of the tube consists of steel bars $\frac{1}{4}$ thick, and, on average, $2\frac{1}{2}$ broad, forming openings of 17 by 9; it is very light, and so stiff that 1 cwt. produced only a deflection $\frac{1}{200}$ inch at 20 feet. The mode of supporting the small specula is described, and the mechanism by which the moving of them for focal adjustment is made easy to the observer. One of these specula is peculiar; it is an achromatized lens, whose coincident surfaces are cemented; its front one so curved that there can be no false image formed by it, its fourth coated pretty thickly with silver. This will be more permanent than the metal, and is expected to give more light.

The equatorial is worthy of the telescope. By inverting the usual arrangement of the polar axis, the eyepiece, circles, and centre of gravity of the whole are brought near the ground; each axis is provided with three sets of counterpoises; the polar with two, which relieve its pivots of lateral pressure; the third lightens the end pressure of the lower one. Those of the declination axes act, two in its plane parallel and perpendicular

to it, the third parallel to the polar axis. They are so effective, that 5 lbs. at a leverage of 20 feet turns the polar axis; $12\frac{1}{2}$ the declination one. A man can raise the telescope from the horizon to the zenith in 20 seconds; two (as both axes must be turned) can reverse it from the east side of the pier to the west in 45 seconds.

The telescope is moved in right ascension by a sector and screw driven by a very effective clock. The regulator of this is so powerful, that an addition of 2 cwt. to its driving-weight only makes it gain six seconds in the hour.

The micrometer has an original mode of illuminating its lines in a dark field, which has been found very suitable for nebulæ.

The spectroscope is on the usual plan, but with special provision for the permanence of its adjustments.

The instrument is also provided with a photographic apparatus, nearly like Mr. De la Rue's celebrated one, which (the small speculum being removed) is placed at the focus of the great speculum. A few trials made with an extemporized one gave pictures which that gentleman considered to be of great promise.

A high opinion is expressed both of the optical and astronomical powers of the instrument.

June 18, 1868.

Lieut.-General SABINE, President, in the Chair.

Prof. Clifton, Dr. J. Barnard Davis, Dr. Duncan, Dr. Pettigrew, Mr. Stone and Mr. Vaux, were admitted into the Society.

The following communications were read:—

I. "A Contribution to the Knowledge of Persulphide of Hydrogen." By A. W. Hofmann, LL.D., F.R.S. Received May 25, 1868.

This remarkable body was first observed by Scheele, and subsequently examined by Berthollet; our knowledge of this substance is, however, more especially due to Thenard, who, soon after the discovery of peroxide of hydrogen, was led also to investigate what was believed to be the corresponding sulphur-compound *. The composition of persulphide of hydrogen has nevertheless remained doubtful. Thenard points out that the specimens analyzed by him, contained variable quantities of sulphur, but always more than would have been met with in a sulphur-compound corresponding to peroxide of hydrogen †.

* Ann. de Chim. et de Phys. vol. xlviii. p. 79.

† Thenard states that all his analyses yielded more than 4 atoms of sulphur for 1 molecule of sulphuretted hydrogen.